Research Study on Condition monitoring power transformer using ANN and Fuzzy Logic

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Abstract - This work covers problem identification due to faults in power transformers during operation by using gas analysis such as key gas, IEC ratio, Duval triangle techniques, and with fuzzy logic approaches. Then, the status of the power converter is evaluated in terms of percentage error rate and internal error resolution. Fuzzy logic with key gas method was used to calculate the error rate and identify the problems in the power converter.

Key Words: IEC Ratio Method,ANN,Fuzzy Logic

1.INTRODUCTION

This Power transmission (transformer) is the main source of electricity transmission and distribution. During operation, it will be damaged in normal and abnormal conditions, including overload, aging and damage of oil insulation paper, internal arcing and partial discharge (PD) , short circuit, etc. - Replace the ball valve (OLTC), winding and metal core, bushing, tank and other damages [1]. Therefore, in order to prevent malfunctions and maintain the quality of the power transformer, many diagnostic and non-standard methods have been carried out to evaluate the situation. Conventional diagnostic methods include dissolved gas analysis, oil quality, power factor testing, winding resistance measurement, turn rate, and thermography, while non-conventional diagnostic methods include partial discharge measurement, dielectric spectroscopy, frequency response analysis, and tap-changer monitoring. and the internal temperature. measurement [2]. After obtaining the test results of the various diagnostic methods mentioned above, the data was further evaluated in order to assess the condition of the power transformer. Most methods performed DGA with a simple tool to find out the incipient defect. However, in industrial applications, it is inconvenient and time-consuming due to the complicated analytical process [3]. Therefore, artificial intelligence techniques have been proposed to develop more accurate diagnostic tools based on DGA data. The method of fuzzy logic is also an effective method for determining the answer where the boundary is not clear.

2. METHODOLOGY.

If the transformer suffers under any faulty or abnormal condition then the dielectric strength of oil reduces also the several types of gases are produced in the transformer tank. This will leads to the gases produced in the transformer tank will get saturate on the top of the oil in the conservator tank.

This gases has their own chemical composition and different nature that gases will developed a major fault, if the transformer is not kept under surveillance after a specified period of time. For the better operation and efficiency of transformer needs to be get checked and maintained health of the transformer.

For the above purposes, with the help of DGA test and fuzzy system can check the Di-electric strength of transformer oil and predict the kind of fault and the time till which transformer operate at better efficiency.

The Partial Discharge, Thermal Fault, Energy Arc Fault are the faults which will appear on the transformer if the proper check-up and maintenance is not done.

The rating of the power transformer is 3-phase 16 MVA 132/33KV located at MSETCL 132KV substation situated at Achalpur, Dist.Amravati.

The Dissolved Gas Analysis (DGA) with insulating oil can be implemented to identify the condition, interpret faults, and provide early warning of some problems inside the transformer.

By using following methods are used for finding faults in power transformer:

1. International Electric Committee (IEC) Ratio Method
2. Key Gas Method
3. Duval Triangle Method

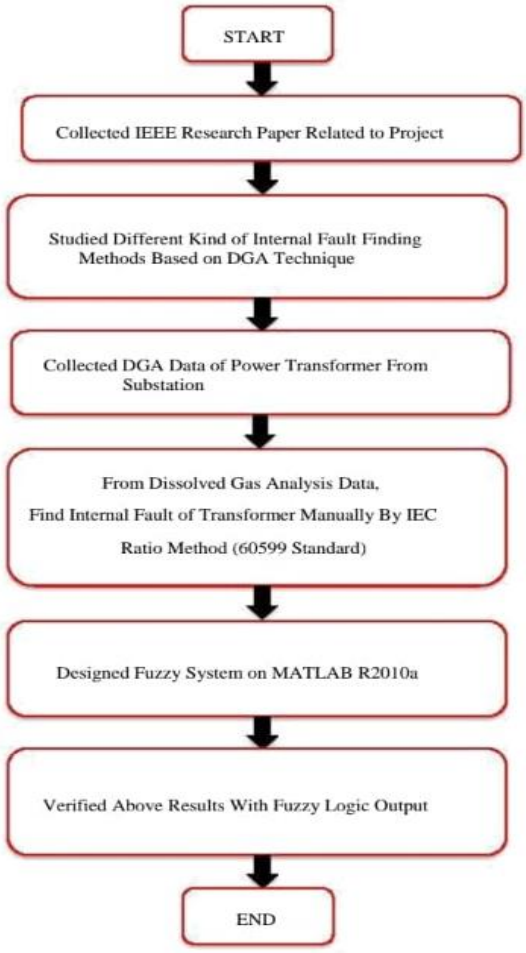
A fuzzy logic approach to DGA method:-IEC three-gas ratio method were used to evaluate the condition of power transformers by the percentage of the failure index and the internal fault determination. Moreover, the fuzzy logic with the key gas approach could calculate %FI and identify problems that may occur inside power transformers, while the IEC three-gas ratio and Duval triangle can confirm the problems in different failure types covering all possibilities inside power transformers.

Following table shows the fault identification using IEC Ratio Method

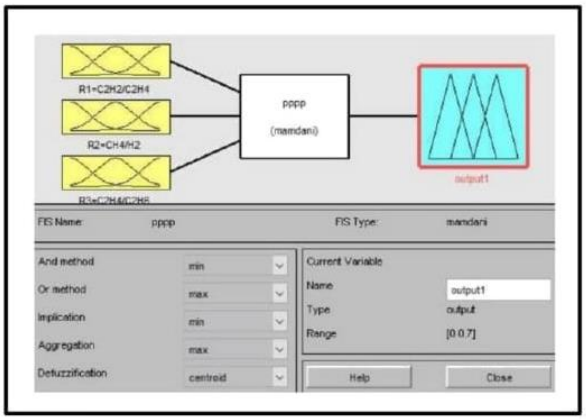
Sr. No.	R1	R2	R3	Fault Type
1	NS	<0.1 (R21)	<0.2(R31)	KD(Partial Discharge)
2	>0.1 (R11)	0.1-0.5 (R22)	>1(R32)	D1 (Low Energy Arc)
3	0.6-2.5 (R12)	0.1-1 (R23)	>2(R33)	D2 (High Energy Arc)
4	NS	NS	<1(R34)	T1 (300°<Thermal Fault)
5	< 0.1 (R13)	>1 (R24)	1-4(R35)	T2 (300°<Thermal Fault<700°)
6	<0.2(R14)	>1 (R24)	>4(R36)	T3 (Thermal Fault> 700°)

Table 1 Fault Identification Using IEC Ratio Method

Flow Chart of Project Process:



3. Simulation Diagram



As the completion of collecting the data of power transformer from the sub-station it is very easy to simulate the monitoring of condition of power transformer .

The shows the basic input and output structure of the project, it defines that three inputs are given to the MATLAB Fuzzy Logic system which decides the single output in the form of either the transformer is under faulty condition or running under normal condition.

Fig indicate the rules defined in the table In this fig the six rules are configured so that if the values of R1, R2, and R3 are match with the any of the condition then the respective fault is considered or the maintenance of the transformer is taken into consideration.

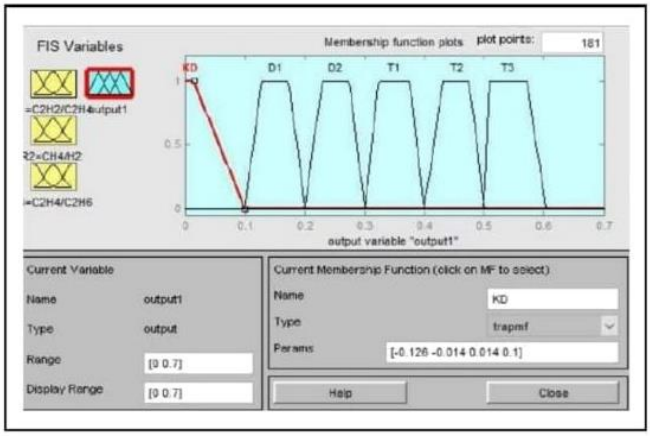


Figure Output Characteristics of Model

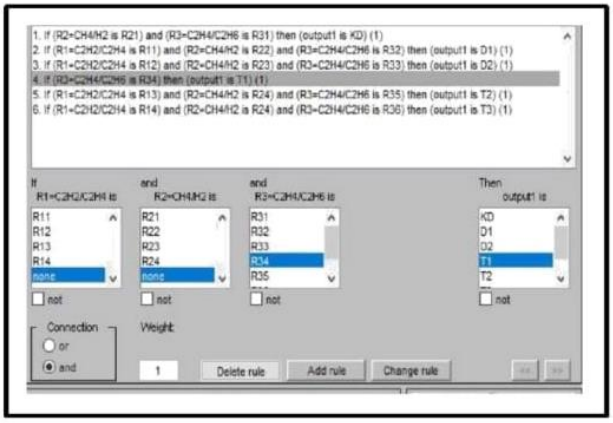


Figure Method of defining Rule base in fuzzy toolbox

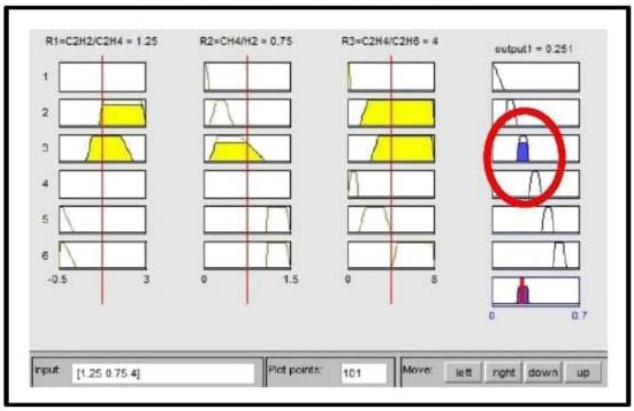


Figure Fuzzy IEC Ratio Method sample case Result View

4. RESULT:

In this case study, dissolved gas analysis was carried out by using the gas densities released as a result of failures in power transformers. IEC fuzzy logic systems has been applied to 25 samples gas concentration values for failure analysis.

Taking into account the limit values of the gases formed as a result of the fault, IEC method is applied to the fuzzy logic, which is one of the smart systems, and the fault is evaluated and the results are tabulated. In the fuzzy IEC method, it is seen that when the memberships of the input functions are used at different intervals, the results also change.

When the results based on IEC fuzzy methods are examined, it is seen that better results are obtained in fuzzy IEC ratio method. At the same time, it was observed that more accurate fault analysis was performed with the fuzzy IEC method compared to the classical method.

Below table indicates the 25 test cases taken from sub-station and the resultant fault on power transformer.

It is seen that 76% of the results are found normal during the simulation and manual calculation based on table.

5. CONCLUSIONS

Fuzzy analysis application to DGA methods The IEC gas ratio method was used to evaluate the condition of the power transformer and determine the internal fault. In addition, the IEC fuel report can confirm the problem in different types of defects covering everything in the engine. In addition, the DGA results of the two transfer systems were also reviewed. Internal problems of power converters are clearly shown.
Fuzzy membership functions represent more accurate relation between the type of fault and DGA samples as reflected in the output results. Also with the method, more than one fault at a time can be identified, which is not correctly diagnosed by the traditional method. The case study also presents diagnosis of faults in a transformer using fuzzy logic based on IEC ratio method which is found satisfactory with the fuzzy diagnosis.

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